Eos, Transactions, American Geophysical Union

DITO Stantitity, feedburg, and flow
coal Suprace to city System part flow
coal System part flow
coal System part flow
coal System part flow
coal System
coal t, Geophya, Mas., B, Papet 480938

Physical Properties of

J. Geoghym. Res., B, Paper 180779

6118 Linspicity, Fracture and Flow DISPLASED FLUID FLOW IN FRACTURED RESERVOIRS: AN ANALYSIS OF TRACER-DETERMINED RESIDENCE TIME

DISIDEBUTIONS

J. V. lester (Chomical Engineering Department,
Passachuselts institute of Lechnology, Cembridge,
Passachuselts institute of Lechnology, Cembridge,
Passachuselts institute of Lechnology, Cembridge,
Passachuselts and a fractured quothermal reservoir
using Lester-determined residence time distribution
[RTB] curves is outhland. Emphasis is placed on
corparison of 150 stall>tical quantities obtained from
the tracer curves of different resorvoirs or 35 same
resorvoir under different conditions. In this way,
rodel-independent informalics may be ased unombiquously

rodal-independent information and transactions. In this way, rodal-independent information may be ased unombiquous) to construct empirical reservoir performance correlations. DownSula measurements of the tracer response action from discrete fracture years permits further characterization of asservoir fluid flow behavior. Tracer experiments conducted in prototype but dry rock (NOR) fractured geothermal resorroirs one associated uting those statistical-based days onalysis methods. Idispersion, tracers, fractures, and flaid flow)

CITO Electricy, fraction, and for
I Fisher Africa Money, of the STREAS-HISTORY DEPENCENCE
OF THE TRUNK SLP
With A Objust [Ocumenhagies Division 1615, faudia National Caboratories,

Vol. 65, No. 33, Pages 473-480

Vol. 65 No. 33 August 14, 1984

Transactions, American Geophysical Union 14

the according to the second se 119 THE TANAE SLP

Win A Obuse [Occarchanges Division 1819, Quadla National Laboratories,
Althorograps, New Mexico SY189]

Frectional highpays on material bateriaces to pervisive in recrebativel problems of all types, but it can be particularly important to groupe handre Extrant models of read-to of founded you wastly take frictional rentence along nor interfaces to be described by suitors, Coulomb frations. A sample theory is presented when the opporation consultions feterous. The description is by means of continuous destrabilisms of suitactional distributions of suitactional distributions of suitactional distributions of suitactional distributions of suitactions are a result in the design of the foundation for the Stateste memory effect therefore during eyeth attention of real, and also indicates potential difficulties in the design and interpret action of experiences on planted real. [Distorations, fortion, distributions, 2019].

J. Geophys. Rec., S, Paper 580939

ITY-CLAY CONTEST SYSYMAYICS OF POORLY-CONROLDATE SANGTOFES

6. J. Kowaliis, L. E. A. house, and c. r. Wang [Ospat]>—
uent of Geology and Geophysics. University of Visconsin,
Hadlson, Visconsia 577661

Madiand, Miscossia 577661

Compressional velocities have been measured as a fonction of coeffining pressure for fourteen Wast Deite electional coeffining pressure for fourteen Wast Deite electional made and a compression of the Percentificate of the pressure of the pressure of the pressure of the pressure of the Percentificate of the Percentifica

J. CeopSys. Sam., D, Paper 431028. Planetology

6576 Surlace of Planeta
VIKING BISIATIC RADAR EMPERIMENT: SUMMART OF RESULTS
IN MEAN-EQUATORIAL REGIONS
RICHARD A. Simpson (Center for Radar Astennomy, Stonford Maiversity, Stanford, CA 94305], G.C. Tyler, and

ford Botversily, Stanford, CA 94305]. G.t. Tyler, and O.G. Schaher

Viking bistalic radar data have been processed saing Hagfors' scallering function to obtain asticates of raw surface roughness of row ground tracks primarily is Mari' aquestorial region. Roughness averies from as little as 0.75° east of Solia and Sini Pleas to at least R'on the western slope of Arafe Mone; these values are appropriete to affactive horizontal scalus of about 25 m., Estimated roughness to externed terrain to generally of 56°, implying the existence of apportance of the processes (possibly soulsed) in scales jess than 100 s. which are not apparaint to ortikal images.

SAN FRANCISCO • DEC 3aslo winter meetin Abstract Deadline Sept. 12 Call for Papers (including abstract specifications) was published in Eos, July 3 and

August 14, 1984

August 14

For more information, write: AGU Fall Meeting 2000 Florida Avenue, N.W Washington, DC 20009

or call AGU toll free at 800-424-2488 or local 462-6903 - Meetings Departs

4 weeks

There is good agreement between bistatic complant the limitos and earth-based results at ground thick heard limitos and earth-based results at ground thick heard sections near the equalor is both creatend termines plains. Surface tilt probability ignestly familiars plains, Surface tilt probability ignestly familiars are seen to peaked then the Hagfors observed forms and the Hagfors model are considerably what payer function for a letter violet of the considerably what payer function for a letter violet of the considerably what payer familiar had been sufficiently at large tilts than gaustan model appear to results obtained using the gaustan model appear to results obtained using the gaustan model appear have overestimated surface consinues by 10-404. He have overestimated surface consinues by 10-404. He have overestimated surface apparently has more filet segments and true surface apparently has more filet segments and acribed by gaustan aton latter. J. Guophys. Res., B. Poper 43098

Map Projections with Freely Variable Aspect

I. Graham Gogley Department of Geography, Treot University, Peterborough, Omario, Canada, K91 7B8

Introduction

Recent contributions to Eos [Spillons, 1981; McBigde, 1981; Alantyla, 1982; cl. also Ross, 1981; McBrule, 1982] have described map projections that will be valuable to occanographers who need accurate bon visually effective displays of the occanic realm. The presem article is an attempt to redress the balance in favor of students of the continents and more generally in favor of workers who need notand in some cases should not-supulate that parallels be horizontal straight lines. There are several very good introductions to the study of map projections [Steers, 1962; Richardus and Adler, 1972; Sonder, 1982], but it remains a somewhat inaccessible subject because of confuser nomenclature and classification, I shall try here to make a grasp of the outlines of the subject more attainable by uning a simpler notation and in particular by generalizing the troublesome concept of "aspert." This leads to a range of caringraphic possibilities for effective portrayal of phenomena that are not regularly distributed with respect to the geographical coordinate

Recent examples of the use of map projections in the geosciences range from entertaining, as in the use [Erklandt, 1983] of Lee's icosahedral projection [Lee, 1976] to display the Seasal geoid, to imaginative [Huger and O'Connell, 1981] and ingenious [Harrison, 1972]. Our impressions of planetary surface morphology are substantially improved by the maps of Venus, Earth, and Mars on orthographic and Sanson projections shown by Kobrick [1982]. On the other hand, problems lo which the earth's rotation, and, therefore latitude, are physically important rend to evoke conservatism in carrographic illustration. Thus, accompgraphers [e.g., Alektyde, 1981; Mantyla, 1982] prefer maps on which lines of latitude or parallels are lucrizonial straight lines. Meteorologists seem to prefer maps on which lines of longitude or meridians are also straight; the use of the cylindrical equidistant projection is very witlespread

among climate mudelers. Simple projections such as the cylindrical equidistant are familiar to everybody, economical to produce, and compatible with the tabular format of most data storage schemes, but there is a price to be paid for this simplit. hy. It is difficult, for example, to visualize the polar regimes adequately on a cylindrical equidistant projection and impossible on a Mercator projection. If geographical latitude is not an especially significant coordinate, as in studies of the distribution of plate humdaries [Cogley, 1984e] or of continental nonphology [Cogley, 1984n, b], there is in principle no reason tother than a deep-routed conviction that north is "on top") why parallels should be horizontal or even why they should be simple curves. Sometimes, maps have to serve conflicting requirements: In palacogeography, base maps must be simple if they are to be convenient [Smith and Briden, 1977; Smith et al., 1981], and palaeoclimatic interests are well served by maps with horizontal par-alleh Je.g., Scotter et al., 1979), but the distribution of the continents is difficult in appre-Oate if several of them are ameared around

the edge of the map.

If $10_0 i < \pi/2$, part

sin 0, = cos 00 cus p

π sgn θ.

 $\theta_c = 0$ $\lambda_c = \lambda_0 + \pi/2$

Then, the rotation x = Sx' is

.cos 0 tos à \"

1 $1001 = \pi/2$, pm

 $\lambda_p = \begin{cases} \lambda_0 - egn \rho \arccos (- \tan \theta_p \tan \theta_p) \end{cases}$

 $\lambda_c = \begin{cases} \lambda_0 + \arccos(-\tan\theta_c \tan\theta_0) \end{cases}$

 $\theta_p = 0 \qquad \lambda_p = \left\{ \begin{array}{ccc} \lambda_0 + \pi & \theta_0 = \pi/2 \\ & \end{array} \right.$

 $0_0 = -\pi/2$

 $\cos \theta \sin \lambda$ = $\cos \theta_r \cos \lambda_r \cos \theta_r \sin \lambda_r \sin \theta_r$ $\cos \theta' \sin \lambda'$

The signum function, sgn, need not be defined for $lpt > \pi/2$, but it is convenient to do so.

sin 0 / cos 0, cos 0, sin \ ain 0, / sin 0'

 $10_{\rm p}1 < \pi/2$

/ cos 00 cos 20 cos 00 sin 20 sin 80 // cos 0' cos 2'

Fig. 1. The algebra of Eulerian rigid rotation in a form suitable for computer cartogra-

10,1 = 11/2

the earth is a sphere, not a spheroid, and in keep the development within manageable limits we deal only with single continuous projections. Interrupted and combined projections [c.g., Spillions, 1983; Suyder, 1977; Miller, 1941] are not tonsidered. They involve complicated peripheral programing. and their appearance is sometimes difficult to predict in aspects other than the threat aspect. To show that the scope offered by continuous projections is very wirle is one of the purposes of this paper.

Aspect Parameters

Nevertheless, we require in general three translate it along one or both of the available directions,

The simplest mental picture of these operations is obtained by looking on the geographical coordinate system of parallels and meridi-ans as a rigid wire mesh fixed in place on the sphere. The eventual map coordinate system can then be seen as a second rigid wire mesh which can be moved over the sphere at will. At first the two meshes coincide, but we can choose to shift the origin of the second mesh anywhere we want and we tan tilt the second mesh at any desired angle to the tust. The map projection is done from the second mesh to the plane of the map. By splitting the pro-cedure in this way we achieve a considerable reduction in the quantity of notation. Projections are always defined with respect to the same coordinate system [the second wire mesh), and the aspect of any map is defined in terms of a rotation which has nothing to do with the projection being used.

x = Sx' (1) where $x = (\cos \theta \cos \lambda, \cos \theta \sin \lambda, \sin \theta)$ is the man coordinate system li.e., that of the second wire mesh), $x' = (\cos \theta' \cos \lambda', \cos \theta')$ sin λ', sin 0') is the geographical coordinate system, and S is the rotation matrix [Kreyszig, 1979, pp. 397-401]. Geographical latitude and longitude are 6' and \(\lambda'\), respectively. The rotation matrix can be specified in terms of three spherical "Enler angles," those chosen here being the geographical latitude 80 and

In what follows we assume throughout that $U = \lambda \cos \theta$ $U = (2\sqrt{2}/\pi) \lambda \cos c$ $R = 2 \sin (\beta/2)$ $R=2\sin{(\beta/2)}$

equations that describes a transformation from three-dimensional spherical coordinates to two-dimensional rectangular coordinates. The inverse transformation is described by a set of inverse equations [e.g., Coglet, 1983]. In most uses of map projections the spherical ra-dius is a constant, and the size of any given map is also a constant. These constants, and possibly a scale factor as well, can be applied as multipliers after other operations are completed, and they need not appear in the equations that thefine the map projection. spherical coordinates to specify completely the transformation from the sphere to the map plane. This is because thiring the trainformation we may wish to change not only the origin but also the origination of the coordinate system. In other words, we may wish to rotate the coordinate system as well as to

Table 1 is a list of selected projection, in-cluding some in compounts and some made

This rotation is formally identical with the finite rotations used by technicists to reas-semble continents; it is defined by

scope for experimentation when the projec-tion is not conical. The fundamental triangle of the projection [Wmy, 1974] is now no longer degenemte, and there is one aspect for each of its vertices, one for each of its sides, and one for its center. Again, the uff-vertex aspects are infinite in number, and again one of the coordinates of the graticule is arbitrary. The aspect parameter to provides only a translation of the earth's surface beneath a graticule the physical appearance of which loes not change; this translation is of course often crucial to the appearance of the fin-

TABLE 1. Defining Equations for Representative Map Projections

```
Asomotho
                                                       R = \alpha

R = \sin \alpha
                                                                                                             azimuthal equidistant
                                                                                        0 \le \alpha < \pi/2
                                                                                                              orthographic
                                                       R = \sin \alpha
                                                                                          π/2 < α ≤ π
                                                       R = 2 \sin (\alpha/2)
                                                                                        ll ≤ a < π
                                                                                                             Lambert azimuthal equiareal
                                                       R = \tan \alpha
                                                                                                             gnomunic
                                                                                         0 \le \alpha \le \pi/2
                                                                                                              siercographic (v. infra)
                                                       R = 2 \tan (\alpha/2)
                                                                                         11 ≤ α < π
                                                                                                               cylindrical equidistant
                                                       V = \sin \theta
                                                                                                               ylimbrical equiareal
                                                        V = (1 + \sqrt{2}/2) \tan (0/2)
                                                                                                               Gall's "stereographic
                                                                                                               Metcator (v. infra)
                                                                                        V = \sqrt{2} \sin c
                                                                                                              Mollweitle (c is defined by 2c + \sin 2c = \pi \sin \theta
                                                                                                                 and can be found by iteration or polynomial
                                                                                         A \simeq 2
                                                                                                              Harnine
                                                                                         A = 7/4
                                                                                                               Briesemeister
                                                                                                         Conformalt
                                                                                                              Mercator
                                                       S = 1anh \frac{1}{2}M
                                                                                                               sterengi aphic
                                                       L = \tanh \frac{1}{4}M
                                                                                                              Lagrange
Miller oblated stereographic
                                                       Mi = S + \mu S^2
                                                                                                              Angust
Lee rectangular
A map projection is a set, usually a pair, of
                                                       Lr = 2 \operatorname{sc}^{-1} (2/\sqrt{k^2})
                                                        Le = \sin[\pi Lr/(4K')]
                                                                                                               Lee ellipric
                                                                                                              Lee tetralochie
                                                       Lt = \operatorname{stl}^{-1} (2 \exp M)
```

Notation: $\theta = \text{latitude}$; $\phi = \text{isometric latitude} = \arcsin(\tan \theta)$; $\lambda = \text{longitude}$; $\alpha = \text{arc distance}$ from origin = arcos (cos 0 cos λ); β = arcos [cos 0 cos (λ /2]]; b = arcos (sin 0/sin α), $tt < \alpha < \pi$; U = map easing = $A_R \sin b$; V = map northing = $R \cos b$; $R(U^2 + V^2)^{1/2}$; A = 1 unless specified other erwise; $i = \sqrt{-1}$. Earth radius and other scale factors (except p) are assumed equal to 1, k', K' are parameters of elliptic integrals; se, sil are Jacobian elliptic touctions (Lee, 1970; Abromowtz and

*Domain is $-\pi/2 < 0 < \pi/2$ and costing $U = \lambda$. †Domains vary, some projections having several singular points; V = ImZ, V = ReZ, where Z is the quantity on the left side of the defining equation.

longitude to of the origin and the azimuth o. The aziouth is the angle made at the origin between rays to the north poles of the gengraphical and map exertinate systems; it is positive counterclockwise from geographical north, so that a positive azimuch puts the geographical north pole in the right half of the map. Figure 1 gives a derivation of the rotation matrix, following, for example, feffers and feffers [1996] but in a form suitable

The Enler angles (00, 80, p) are not the same as those used to reassemble continents. since the three component rotations are alioni different sers id axes in the two procedures. In plate tectonics only one continental outline is rotated at a time, whereas here the entire contents of the map are being rotated. The advantage of choosing bo, As, and a is that they are easy to visualize in terms of the desired end product: 80 and \$0 usually deline the physical center of the map, while o can be estimated with fair acturacy by eye on a globe

more useful or versatile when the principles discussed to this article are applied to them. The table emphasizes that all the commonly recognized aspects of these projections are contained within their defining forontiae and equation (1). Thus, for example, there is no need to discuss separately the direct, oblique, and transverse (i.e., pular) aspects of the stereographic projection. However, the terminology of aspect makes a good introduction to the "new" projections to be discussed in the next section. Wray [1974] shows that in general there are seven distinct aspects, not the conventional three. (There are projections with more than seven aspects, but they are not considered here.) Most of the common projections are conical (i.e., azimuthal, conic, or cylindrical), and in conical projections four of the seven aspects reduce in pairs to the oblique and the direct aspects. Since the graticule has an axis of symmetry one of its coordinates, the longitude, is arbitrary in that a rotation through an angle of longitude leaves the graticule unchanged. Thus for a given λ_0 nully three aspects are available in a conical projection: direct, with $\theta_0=0^\circ$; transverse, with $\theta_0 = \pm 90^\circ$; and oblique, in fact infinite in number but by convention regarded as one, with 0° < 1001 < 90°. In conical projections the third aspect parameter, the azimuth is redundant, and its only effect is to make the image of the graticule. Although this effeet can be achieved more cheaply by looking at the map slantwise, it can be useful to specify the three aspect parameters explicitly in combination with the four "window parameters." These last control the extent of the map and can be specified as the four distances in degrees of arc from the origin to the left, right, top, and bottom edges of the

The three aspect parameters offer more

ished man. However, it is the existence of two nontrivial aspect parameters that makes noncanical projections so interesting.

There are many such projections, but here we shall consider only those that have elliptical limbs. A fundamental fact in the study of map projections is that the sphere is not a developable surface. In ropological terms this means that the sphere cannot be mapped into the plane without one or more cus followed by one or more continuous distonious. For example, the Mercator requires two "pin-pricks," one at each pole of the map graticule, while the stereographic and familieri azimutial equiareal require one pinprick at the antipodes of the origin. In general, projec-tions with elliptical limbs require a cut of length 180° between the poles of the map graticule along the meridian antipodal to the origin: this cur is, in lact, the limb of the projettion. Because we now have three aspect parrangeers rather than two, we are able to make the out along any half great rircle we

Both cars and distortions are inevitable in any map projection, and a practical conse-quence of this is that all maps portray some regions well and other regions badly. When choosing a projection to suit a particular purpose, one of the aims is therefore to assemble the interesting parts of the world in well-portrayed parts of the projection and to have badly portrayed parts of the projection corre spond to less interesting parts of the world of any). A movable limb, as provided by the three aspect parameters, considerably increases the scope for approaching this aim.

In the next section, these ideas are illustrated with a series of maps in which the third Euler angle, the azimuth, is nonzero. The ideas themselves are not new: Finite rotations on the sphere [Jeffreys and Jeffreys, 1956] have been understood for 200 years, and understanding of their application to map projections has grown more explicit during the present century. One of the earliest uses of a nonzero azimuth was by Fairgriere [1928; cf. also Close, 1929], while Spithaus [1942, 1975] seems to have been the first to appreciate the generality and potential of the idea and Wray [1974] provided an important mathematical framework for it. I consider the presentation n above to be an advance becau plifies the nutation; it is probable that the essence of the simplification is already embodied in computer programs at many centers of cartographic research [e.g., Morrison, 1980; Metzger, 1984].

Illustrations

The climate modeling and remote sensing cummunity [e.g., Manabe and Stonffer, 1980; Hartmann and Short, 1980] seems to be content to show its results in very simple cartographic format. Climatologists do not often venture beyond cylindrical projections, tisually the cylindrical equidistant, supplemented ov assorted transverse-unpect maps of the north and south polar reginns: Stephens et al.'s use [1981] of the Hammer projection is unusual. This is a pity because the interaction of the poles with the middle and low latitudes is a central problem in modern cilmatology. Such questions as why the equatorial regions, are not littler than, ~30°C, why the south pole is colder than the north pole, and why the equator-to-pole temperature difference is of the order of 50°C (rather than 20°C as

Article (cont. on p. 482)

Article (cont. from p. -181 L

TABLE 9 Usuful Sets of Ameri Parameters

Parameter	Subject	Source
25, -5, 30	landmasses (limb from Alaska 10 southern Pacific)	Cogley*
28, 178, 70	landmasses (limb Irsan Florida us Inclian Occau)	Cogley*
60, 141, 70	cuntinents	Cogky [1984a, b]
45, 80, ~30	Eurusia	Gogley [1984b]
50, –90, lu	North America	Logley [1984b]
	Altoemrasia in from hemisphete	Cogley*
30, 60, -13 45, -30, -90	landmasses (limb from east Pacilic to central Unlian Ocean; poles on horizontal midline)	Bariliolomew's allases
45, 0, 0	inhabited landmasses	Briesemeister [1953]
0, 20, -70	landoiasses (limh from Hanoi io Ignique)	Spithaus [1975]
-70, 15, 90	world ocean	Spithous [1942]
0, 48, -45	British Commonwealth	Fairguieve [1928]
37, 12, 15	glidbal plate broundary system, cut by limb in only one place	Cogley [1984r]
-35, 168, 20	ghibal plate boundary system, cut hy finib in only two places ("back view")	Cogley [1984c]
0, λ ₀ , ±90	theraform equator enclosing poles	various [e.g., Skers, 1962]

In degrees. *Unnublished data.

during the Cresaceous), are not answerable hy cartographic means; however, a more venturesome use of available map projections may help in deciding, for example, whether these questions are the right ones to ask. The top ligure on the cover shows the global distribution of annually averaged surface albedo on a Midlweide equiareal projection with asperi parameters $(\theta_0, \lambda_0, \rho) = (0, 50, -90)$. Surface alliedo is an important climait variable because of its ride in the radiation balance and the feelback which it provides through its nonlinear dependence on temperature. The top ligure on the cover shows that the hemispheric distributions of surface albedo are quite different. Hoth have polar maxima. but the northern maximum is more extensive and of lesser amplitude than the southern. Superimposed on the dominant zonal alignment of the continues can be seen the innortant following of land-sea contrasts, the lesser but significant roles played by sea ice extent and dynamics and by subsidence in tropical latitudes, and a variety of meridional structures thre to topography and other factors. A map in which both poles are equally well displayed can be a thought-provoking adjunct to conventional maps in which either both poles are bally displayed or one pode is not shown at all. Naturally, one does not ger something for nothing: We have had to sacrifice realism ut the equator, which has become a therashaped object comprising the ventral midline of the may and the limb

The buttom ligore on the cover illustrates a



Fig. 2. The topography of the continent of North America, thrawn at a vertical interval of 1 km on a Hammer equiareal projection (50, -90, 10).

oblem in which the regions around the limb of the map can legitimately be regarded as "uninteresting," This is an attempt to show the cuntinents in their relationships to each milier, with particular reference to their extent and to their serial contiguity. The aim is thus to keen confinents away from the limb, and to do this it is necessary to find a half great citcle which passes entirely through the oceans, A number of lines meet this requirement, Spillmu [1975] suggested a limb extending from Hunoi to Iquique and defined by the aspect parameters (0, 20, -70), but this imb cans through continental crust in the South China Sea. In the bottom figure on the cover the limb runs from the neighborhood of Guatemala 10 a point west of Perth, Australia, and produces a pleasing and informative arrangement of the continents.

The map is ilrawn on a projection due to Lee [1976] which achieves the remarkable feat of mapping the whole sphere conformally into an ellipse. The common conformal proections have one or mure points at infinity. and this new whole-earth conformal manping, which is free of gruss distortion, deserves to be more wilely known. It is important to camion the viewer that the conformalify of the map guarantres local correctness of shape but at the same time guarantees in-equality of areas from locality to locality. The continent of New Zealand is somewhat smaller than Arabia, nut several times larger, and the cuminents as a whole occupy 41% of the earth's surface, nor -20% as suggested by the bottom figure on the cover. Most of the continents, however, are displayed with compara-tively minor interior distortion, and regional subjects such as the separation of Madagascar from Africa or of South America from Autarctica are accurately depicted. For some purposes the separation of Antarctica from Anstralia might be considered a flaw, but this ean easily be remedied with a different choice of aspect parameters. Table 2 lists several other parameter sets that serve a variety of purposes related to large-scale tectonics and oth-

The apparatus used in selecting the parameter sets of Table 2 consists of a globe and a ength of knotted string. Usually a first guess followed by a fine adjustment is enough to vield satisfactory results

Note that the selection of a particular aspeci is independent of the choice of map projection. The same map as shown as the boltont figure on the cover is shown in Cogley [1984a] ou a Hammer equiareal projection.

The mility of projections with three nonzero aspeci parantetets is not restricted to maps of the whole world. Figure 2 is a map of the cuntinent of North America drawn on a Hammer (50, -90, 10); the origin is at the

Fig. 3. A palieogeographic map for the Wenlockian (middle Silurian [Scotte et al., 1979]) on a Briesenteister equiareal projection with the aspect parameters (-35, 20, -30) chosen so as to keep land masses away from the linb of the map.

laeogeographic maps some of the important details are unrecognizable because they are near the edge of the map. The cost is only partly recouped by presenting back views as well as front views, a point well illustrated by the middle Silurian maps of Scotese et al. [1979]. Figure 3 shows some of the detail from Scotese et al.'s Figures 15 and 16 on a Briesemeister (-35, 20, -30), which has a limb passing through the oceans of the Silurian world. The convenience of straight parallel and zonal symmetry is lost in Figure 3 but is partially regained by emphasizing the paral els and the poles at the expense of the merillings which are somewhat arbitrary in this context). Maps such as Figure 3 are valuable supplements to standard palaeogeographic maps because palaeoclimatology is only a part of palaeogeography. Magnetically determined palacolatifides are of course the key to continental reconstruction, but, apart from this reclinical point, geographical latitude is only significant in palaeorectonics if one wishes to consider ellipsoidal membrane stresses. Maps such as Figure 3, and for that matter the bot-

clockwise rotation gives the map a qualinative symmetry which would be lacking if its center

reatment in standard maps centered on the

equator or the north pole, and few printed maps are equiareal. Equality of areas is a pre-

requisite for purposes such as the hypsomet-

ric comparisons for which Figure 2 was

drawn [Cogley, 1984b].

As a final illustration of the potential nl

skew projections, consider a problem men-

tioned earlier, viz., the difficulty of simulta-

neously achieving conflicting aims in palaeo-

geographic mapping. The need to appreciate at a glance the latitudinal disposition of the

continents is rightly regarded as paramount

with et al. [1981]. However, the price paid

tom figure un the cover and Figure 2 also.

have exactly the same mathematical validity

and physical meaning as maps that have sym-

metry with respect to the earth's axis of rota-

tion, and they share their stated purposes ei-

advance in cartographic technique which

Acknowledgments

123-155, 1983.

References

assistance with computing.

should help earth scientists to increase the

versatility and sophutication of their pictures of spatially distributed phenomena.

I am grateful to Ted Buelow for continued

Abramowitz, M., and I. A. Stegun, Handbook

Briesemeister, W., A new equal-area projec-

tion, Geogr. Rev., 43, 260-261, 1953. Clase, C. F., An oblique Mollweide projection

of the sphere, Geogr. J., 73, 251-253, 1929. Cogley, J. G., DIGIT—An interactive proces-

sor for diguized data, Computers Geosci., 9,

Cogley, J. G., Continental margins and the

extent and number of the continents. Rev.

Ceophys. Space Phys., 22, 101-122, 1984a.

Cogley, J. G., Hypsometry of the continents, Zeit. Geomorph., in press, 1984b.

Gogley, J. G. Glubal plate statistics, Tectonics,

Eckhardt, D., Cover, Eos Trans. AGU, 64, 424,

Falrgrieve, J., A new projection, Geography, 14, 525-526, 1928.

Hager, B. H., and R. J. O'Gonnell, A simple

Harrison, C. G. A., Poles of rotation, Earth

Planel, Sci. Lett., 14, 31-38, 1972.

Hartmann, D. L., and D. A. Short, On the

37, 1233-1250, 1980;

use of earth radiation budget statistics for studies of clouds and climate, J. Almos. Sci.,

global model of plate dynamics and mantle convection, J. Geophys. Res., 86, 4843-4867.

of Mathematical Functions, Dover, New York,

ther equivalently or better.

by such workers as Scolese et al. [1979] and

for this decision is that in at least some pa-

ine were a geographical meridian. The

northerninosi and westernmost parts of

North America often receive inadequate

Conclusion The convenience of maps on which parallels and meridians are regular curves is ubvi-ous: It is easy to add detail to them by hand, and the results of different workers are easier to compare if they are shown on midely used projections. Mure adrenturous use by the geoscience community of a wider range of projections would, lyswever, he a welcome development. It would help us in the generation of new questions and in the unlearning of old prejudices. For example, the large size of Greenland and the remoteness of Siberia and Alaska (which are tectonically contiguous) are witlely and wrongly believed in because of our limited cartographic diet. The tectonics of the Arctic remains obscure today for a number of reasons, among them not only the inaccessibility and complexity of the subject matter but also the choice of direct-aspect Mercator maps to express the main ideas of plate rectonics in the 1960's. Similarly, muc eannot help but suspect that the weakness of general drentation climate model performance at high latitude is due in some part to mapping conventions which deemphasize the geography of the polar regions. Divorcing the aspect of a map projection from its delining equations, as explained above, is a valuable

center of the object of attention, and a small

-orum

Moving AGU Meetings Sites

A recent letter to East by AGU member Dan Baker (March 14, 1984, p. 98) suggested that a method of reducing the atendance at the Fall AGU meeting would be to move it from San Francisco to his namesake, namely Bakersfield, He cited a a precedent the probably reduced attendance at the fat that time) upcoming Spring Meeting to be held in Cincinnati While neither of us is promoting cities with names similar to ones, nevertheless we bull believe that the recent meeting held in Cincinnati was a great success. even with the reduced number of registrants. The arrangements in the Conver tion Center, as well as the proximity of the hotels to the convention center and the amenities in the hotels were all excel lent, and easily matched or surpassed the facilities in any of the cities in which the major meetings have been held to dus time. Furthermore, we would like to make a qualitative judgment that the number of attendees at the individual sessions were perhaps as large as in a Baltimore or Washington meeting. In those meetings the number of registrants may have been larger, but the number of attendees at the given session may have been smaller; a significant proportion of the attendees at any given time would likely be visiting the offices of their contract monitors. Admir redly, the Spring Meeting has been an ide al opportunity to both attend scientific sessions and to lubby for additional research support. However, such lubbying does not necessarily make for increased attendance i the scientific sessions.

In summary, we applied the program committee for finding such an excellent site for a meeting as Cincinnati. We think that those who failed to attend missed an excellent technical meeting as well as one with ourstanding logistical arrangements

> L. Lanzeroli C. C. Macleman ATGT Bell Laboratorie Athrony thil, N.J.

Hummet, J. R., and R. A. Reck, A global surface albeite model, J. Appl. Meteorol., 18,

239-253, 1979. Jeffreys, 11., and B. S. Jeffreys, Methods of Mathematical Physics, 3rd ed., Cambridge University Press, New York, 1956. Kohrick, M., Vopusgraphy of the terrestrial planets, Astronomy, 10, 18-22, 1982.
Kreyszig, E., Advanced Engineering Mathematics

ics, 4th ed., John Wiley, New York, 1979. Lee, L. P., Conformal projections based on elliptic Functions, Cartographica, Monogr. 16, B. V. Gutsell, do Univ. of Turonto Press. Torunta, Cint., 1976.

Manabe, S., and R. J. Stoulter, Sensitivly of a glubal climate model to an increase of COz conventration in the atmosphere, J. Geophys. Res., 85, 5529-5554, 1980.

Mantyla, A. W., Projection panderings, Est Trap. AGU, 63, 179, 1982. McBryde, F. W., Fundering projections, Es Trans. AGU, 62, 1162, 1981.

McBryde, F. W., Mullweide graticule shortcumings, Fas Trons. AGU, 63, 522, 1982. Meizger, D., Cover, Eus Trons. AGU, 65, 156.

Miller, O. M., A constantual map projection for the Americas, Geogr. Rev., 31, 100-104.

Morrison, F., Computing the potential and attraction of a density layer by means of elliptic integrals, Manuser. Geodaet., 5, 145-

Richardus, P., and R. K. Ailler, Mop Project tion, North-Halland/American Elsevier,

New York, 1972. loss, D. A., Marine science and the law of the sea, Eas Trans. AGU, 62, 650-652,

Scolese, G. R., R. K. Bambach, G. Barton, R. Van der Voo, and A. M. Ziegler, Paleozok base maps. J. Geol., 87, 217-277, 1979.

J. G. Gogley is on associote professor of geography at Trent University, where he lectures in geology, geomorphology, climatology, and related subjects. He took his B.A. from the University of Oxford and his M.S. and Pk.D. from McMaster University. University. After o visiting year of the University of Toronto, he has been at Trent since 1974. His doctorns work was on the fluviol geomorphology and hydrology of High Arctic terrains on Devon and Cornwallis islands and developed into an anolysis of water and energy balances, It food to the search on ice-dommed lahes on Ellesmere Islandand on the hydrological problems of possible pipe-line routes on Ellesmere Island and in Keewalin. More recently, his work has focused on problem in paleogeography and the dynomics of ancient city motes, cloud and radiolion climatology of the Art to Inc. tle, large-scale geomorphology and lecturies, and geoscience opplications of computer graphics. He is especially interested in strengthening the internation between himself of the strengthening the internation. believen physical geography and geophysica.

Smith, A. G., and J. C. Briden, Mesozoic and Counzoic Paleocontinental Maps, Cambridge University Press, New York, 1977. Smith A. G., A. M. Hurley, and J. C. Briden,

Phanerozoic Paleocontinental World Mahs.

Cambridge University Press, New York,

Snyder, J. P., A comparison of pseudocylin-drical map projections, Am. Contegt., 4, 59-

Snyder, J. P., Map projections used by the

Geogr. Rev., 32, 431-435, 1942.

Bull. 1532, 1982.

to, Ont., 1974.

U.S. Geological Survey, U.S. Grol. Surv.

ionic solids, Eas Trans. AGU, 56, 52-57,

Spilhans, A., Opinion. Ees Trans. AGU, 62.

Steers, J. A. An Introduction to the Study of

London Press, London, 1962.

May Projections, 13th ed., University of

Stephens, C. L., C. G. Camphell, aml T. H. Vonder Haar, Earth radiation budgets. J.

Wray, T., The seven aspects of a general map

Do you know

a colleague who

would like to loin AGU?

Call 800-424-2488

and request membership

applications.

The Weekly Newspaper of Geophysics

For speediest treatment of contributions send

three copies of the shouble-spaced Hammarija to one of the editors named below and one copy to

Editor-In-Chleft A. F. Spilliaus, Jr.: Editors: Marcel Ackerman, Mary P. Amberson, David A.

Brooks, Brice Die, C. Stewart Gilling (History), Clyde C. Goad, Louis J. Lanzerotti, Rober

A Phinney; Managing Editori Michael Sthwarz; News Writers Barban T. Richman; News Assistant: Tony Sciebbard; Production

Staffi Dae Sung Kim, Patricia Lichlello, Lian Lichtenstein, Cymhia T. McManigal, Kathryn

harles L. Drake, President; Peter S. Engleson

President-Elect; Peter Al. Bell, General Secre-ary: Juan G. Roedeter, Foreign Secretary; james A. Van Allen, Part President; A. F. Spil-

aus, Jr., Executive Director; Waldo E. Smith

For advertising information, contact Robin E. Little, advertising coordinator, at 202-462-6903 or tall free at 800-424-2488. Advectising trees the informative and consistent with the scientific and education.

tional goals of AGU and is subject to approval by AGU. Advertisers and shelr agents assume li-ability for all content of their advertisements and for any claims arising therefrom against the publisher. Offers in advertisements are subject to all laws and no world adverse medical

o all laws and are vold where prohibited.

Copyright 1984 by the American Geophysical Union, Material in this issue may be photocop

hort quotes and figures and tables for publica-

tion in scientific books and journals. For permission for any other uses, contact the AGU Publi-

lens expressed in this publication do not nec-

inbscription price to members is included in an

aual dues (\$20 per year). Information on insti-tutional subscriptions is available on request.

Second-class postage paid at Washington, D. C., and at additional mailing offices. Ecs. Transactions, American Geophysical Union (ISSN 0098–3941) is published weekly by

American Geophysical Union 2000 Florida Avenue, N.W. Washington, DC 20009

Cover. [Top] Annually averaged surface albedo, based on the 10° x 10° estimates of

lumner and Reck [1979]. The projection is

a Mollweide with aspect parameters (0, 50,

rojection is a Lee elliptic conformal (60, 0. 70). (Figures courtesy of J. Graham

Cogley, Department of Geography, Trent University, Peterborough, Ontario, Gana-

da See article, "Map Projections With Freely Variable Aspect," by J. Graham

Cogley, this issue.)

-90). (Bottom) The extent of the contlments, after Cogley [1984a], with sub-merged and subacrial portions indicated by yellow and brown, respectively. The

usually reflect official positions of the American

led by individual scientists for research or clar room use. Permittion is also granted to use

Officers of the Union

tennire Director Emerites.

projection, Cartegraphica, Monogr. 11, B. V.

Gusell, do Univ. of Toronto Press, Toron-

Geophys. Res., 86, 9739-9760, 1981.

Satellite Troubles

Two satellites operated by the National Oceanic and Armospheric Administration (NOAA) encountered serious trouble recent-

The Geostationary Operational Environ-Spilhaus, A., Maps of the whole world ocean, mental Satellite (GOES) that provided weather pintures for the eastern half of the United Spilhaus, A., Ceo-Art: Plate tectonics and pla-States and Canada, all of Central and South America, and much of the Adamic Ocean, failed on July 29; an incandescent lamp for the encoder burned ont. In mid June, the NOAA-8 environmental monitoring satellite Spilhaus, A., Cover, Eas Trans. AGU, 64, 136, lost its attitude control system and began tumbling in orbit at the beginning of July. The satelline includes a payload called SAR-SAT that enables the satellite to telay emer-

> In response to the blanking out of GOES-5, also known as GOES-East, NOAA mixed its and Vernion. For example, flow of the sister satellite, GOES-6, also known as GOES-West, eastward from over the equator at 135°W longitude to 98°W longitude, according to William M. Callicott, deputy director of NOAA's office of satellite data processing and distribution. The troubled GOES-5 had been at 75°W longitude. The shift enabled GOES-6 to monitor the United States and to help watch for harricanes during this peak season. The western Pacilic Ocean, Hawaii, Alaska, and the eastern portion of the Atlantic Ocean are not being monitored by a geostationary satellite, but polar satellites pass over the ar-

eas twice daily Although GOES-5 can no longer make intages to send to carth, its communications transponder still works, Callicon said. Data collected by the functional GOES-6 can be transmitted over the GOES-h transponder; weather fatsimile data also can be processed for users at the fringe of the satellite corer-

age.
Built by Hughes Aiscraft Co. and knumbed in 1981, the \$4tt-million GCtES-5 satellite was expected to operate for 5 years. The four salellites preceding I/OES-5 also failed earlier than expected. The failure of the COES-5 satellite has "created a lot of consternation," Calliton said, and some of the dynamics of the weather patterns have been missed. Thosever, storm warnings can be issued adequately with GOES-6. The next GOES sparecraft is

scheduled to be launched in Mar 1986. Backup for the other troubled satellite. NOAA-8, is being provided by the SOAA-0 saiellire. NOAA-B, which can cover much of the environmental monitoring lost by the failure of the NOAA-8 smellire, has the ability to process images, not soundings, however. The NOAA-8 satellite, launched March 28, 1983, is the first in a series of three advanced TI-ROS-N satellites. It began shoring problems on June 12, according to Charles E. Thieuel, deputy mereorological satellite project man-ager at the Goddard Space Flight Genter, On that tlay, the satellite's gyros desynchronized. Cominmed clock disturbances interfered with the meteorological instruments, preventing the transmission of good data. Over the weekend of June 30 to July 1, the spacecraft began tumbling. The secondary oscillator, which would be the automatic backup to the printary oscillator that failed, is not accessible via remare control. The next advanced Tl-ROS-N satellite, scheduled to be launched November 2, will be able to be controlled remotely, Callicott told Ess.-BTR

July Streamflows

Flows of most of the nation's key index streams were average to well above average in the first full month of summer, according to the U.S. Geological Survey (USCS), Department of the luterior.

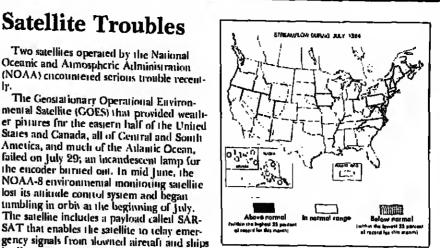
A USGS network of 173 index gaining stations provided the vegular month-emi check of the status of streamflow conditions across

Volcanic III the country. During July, flaws at 83 sites (48%) were well above average, that is, in the upper 25% of long-term record. Seventy-one stations (41%) were in the normal range. Only 19 stations (about 11%) were hi the luw est 25% of record.

The generally above average streamflow was reflected in conditions of the three major U.S. rivers. The combined average flow of the Mississippl, St. Lawrence, and Columbia rivers was 820 billion gallons per day |bgd), or 30% above average for the month. The three rivers drain more than half of the lower 48 states, thus providing hydrologists with a quick check on the status of the nation's wa-

Average flows at the key USGS stream gauging stations were in the upper 25% of long-term record for July in most of the northeast; the Middle Atlantic states into Georgia; and the upper Mhlwest, Rocky Mountains, and Pacific Northwest states.

Record high or near record high average flows for July occurred at 18 key locations in 16 states: Alaska, California, Connecticu. Florida, Georgia, Iowa, Maine, Minnesota, Nevada, New Jersey, New York, Oregon,



and Vermont. For example, flow of the Etuwali River at Canton, Georgia, averaged a

1.1 bgd, the highest measured flow for July since teconikeeping began at the site in 1936. In contrast to the many repous of streamflow in the recurrd high range, record low or near record low flows occurred at seven sites; three in Hawaii, two in Texas-where drought conditions persisted—and one each in Alabama and Puerro Rico.

Hydrologist Hai Tang of the USGS National Center in Resion said that groundwater levels were allowe average over most all the country in July. Monthly low levels for July occurred at key observation wells in San Autonio and El Faso, Texas, reflecting the general below average precipitation and streamllow conditions that have persisted in parts of Texas for 11 of the last 12 months.

Tang said the contents of reservoirs were generally average to above average in most of the country, with exceptions noted in Texas.

southern Oklahowa, and western Kansas, The U.S. Geological Survey, in cooperation with state and local organizations, tentinely gathers data on the quantity and quality of surfacewater and promulwater resources. from more than 60,000 stations across the

Following is additional information on the tional water conditions:

Five Large Rivers. While the average those of each of the "Big Five" tivers declined seasonally from the previous month, the individnal streamlhows of all were above the longterm average for July. The St. Vawrence Riv-er near Masseng, New York, 197 Iggl, 125 above average; the Ohio River at Louisville, Kennicky, 39 bdg, 24% greater than the long-term average; the Missouri River near Hermann, Missunri, 98 bgd. 101% abuve average; the Mississippi River at Vickshurg, Mississippi, 431 bgd. 58% abuve average; and the Columbia River at The Dalles, Oregon, 192 bgd, 6% greater than the long-term aver-

Nevada. Screamflow was above average on the Virgin, Humboldt, and Walker rivers. The flow of the Humboldt was in the above nurnal range for the 25th consecutive month. Rainstorms in the last 10 days of July caused numerous flash floods in the Moapa Valley and Las Vegas.

Utah. The level of the Creat Salt Lake declined more than 2 inches during July, after peaking early in the month at 4209.25 feet above sea level, which was 4.25 feet higher than on July 1, 1983.

Texas. Streamflow runoff was well below average across most of the state. Thirty-two of 37 reservoirs registered a decline in contents from the previous month. Groundwater levels were below average in key observation wells at Austin and Houston and reached new lows for the month of July at El Paso and San Antonio.

Volcanic Update

A relatively low level of earthquake activity and reduced rates of grunnil deformation during the past year have led U.S. Genlagical Survey (USGS) scientists to conclude that the likelihood of liminiment volcanie activity at Long Valley, Calif., Is reduced from that of

mid-1082 iltrough 1983. In a letter dated July 11, 1984, USGS Di-rector Dallas Peck advised the California Office of Emergency Services that, based on the assessment of the current situation, a volcanic eruption does not pose an Immediate threat to public safety in the Long Valley region.

James F. Darls, Galifornia state geologist

and chief of the conservation department's mines and geology division, concurred with the USGS update. The conservation department acts as the geological advisor to the Cal-ifornia Office of Emergency Services. The Department of Conservation acts as the geo-logical advisor to the California Office of

Emergency Services.
USGS scientists, working with state, local, and university officials, reported that enrihquake activity within the Long Valley caldera

and in the Sierra Nevada burnediately south of the caldera has persisted at a relatively low level, with short periods of increased activity, since a strong earthquake swarm shook the area in early January 1983 (Eas, February 8, 1983, p. 49; March 1, 1983, p. 81; March 29, 1983, p. 122). Quake activity within the caldera has averaged one in two earthquakes of magnitude I or greater shall; an occasional earthquake with a magnitude greater than 3 has been felt occasionally in the region. The two largest earthquakes to occur in the caldera since the January 1983 swarm were a magnitude 4.2 shock on April 28, 1984, and a magnitude 3.8 event on July 16, 1984. This most recent event, recorded July 15-16, was part of a swarm of several hundred earthquakes centered about 2.4 km cast of Mammoth Lakes. It was similar to swatms that occurred reneatedly in the same area between May 1980 aml May 1982.

In addition, geodetic networks show that ground deformation within the caldera has well significantly compared to rates from mid-1979 to January 1983. Horizonial extension is continuing in the southern part of the calders near the site of the January 1983 earthquake swarm, but there has been only sight vertical uplift or ground swelling since January 1988.

Peck advised, however, "Even with this reduced level of activity. Long Valley still has one of the highest microcarthonake rates in California and the ongoing horizontal deformation cates in the southern section of the Long Valley area are nearly 10 times greater than those continely incasured along the earthquake-prone San Andreas fault system. For these reasons, and because of geologic evidence of recent volcanism in the region, the area most still be tecognized as having the potential for educatic activity.

The USGS continues to monitor the region closely. David P. Hill is the chief scientist for the USGS monitoring efforts in the Long Valley region.

New Space Office

The National Aeronauties and Space Administration (NASA) has established an Obhee of Space Station to direct the agency's elforts to develop a permanently manned space station within a decade (Em, February 14, 1984, p. 51).

The new program office, located at NASA beadquatters in Washington, D. C., will provide overall pedier and program direction for the space station program. The space station program office at the Johnson Space Center n Housion, Tex., will report to the new progrant office. Space stating project offices at other NASA centers will be responsible to the new office through Johnson Space Center. The Johnson Space Center was named the

id center for the space station in February. Philip E. Culbertson, appointed associate administrator for space station, will head the new program office. The deputy associate strator for space station will be John D. Hodge. Culliertson had been associate deputy administrator of NASA since November 1981. Hodge hall been director of the space station task force since May 1982; this past April he had been appointed acting deputy director of the interim space station progrant office.

Precambrian Geological **Evolution**

Geologists from Brazil, the three Guianas. Venezuela, the northern Andean countries, North America, and Europe are participating in a new project of the International Geologi-cal Correlation Program, concentrating on the Precambrian geological evolution of the Ama zonian region. Most of the major Precumbrian rock units of the region are currently being studied by geologists in the various countries that have exposures of the Gujana and Gunporé shlekls, which make up the Amazonian craton. The eratum is notable because of the great expanses of crust that formed in the Early Proterozoic, There are graniteensione terranes as extensive as those of the Archean provinces of the North American shield and high-grade gneiss and granulife ferranes of both Archean and Proterozide age. These provide opportunities to compare continental forniation and evolution of Proterozoic age with their more ancient counterparts in other shields. Most of the eraton was established in the Early Proterozoic and was affected by the Trans-Amazonian grogent; about half of this was then covered by Middle Proterozoic intracratonic sedimentray basins, associated felsic volcanics, mafic intrusives, and epizooal granitoid rocks. The felsic magmatic rocks of the Middle Proterozoic are particularly extensive and well exposed: This must rank as one of the prime regions in the

News (cont. on p. 484)

News (cont. from p. 4831

world to snuty such rocks. Alkaline complexes with associated carbonatites occur in Brazil. Goyana, and Venezuela. All of the rock types mentioned have important ore deposits awaciated with them, and one of the goals of the project is to develop further understanding of the mineral potential and metallogenesis of

Project 204 of the IGCP was uthically formed in February 1983, with Wilson Texeira and Culombo Tassinari of the University of San Paulo, Brazil, as coordinaturs. An orgastizational meeting of geologists from Brazil, Colombia, Guyana, Venezuela, and The Netherlands took place in November 1983 in Manasis. A second meeting of the project was held in outsuction with the Seould Amazenian Symposium in Manaus un April 8-12, 1984. Geologists From Brazil, Venezuela. Guyana, French Guiana, the United States and The Netherlands attended and presented papers.

The Second Amazonian Symposium way held to commemorate the 50th anniversary of the Brazilian Departamento Nacional da Producao Mineral (DNPM). Over 50 paners were presented, and a 518 page volume of proceedings was releast at the time of the conference. The papers igcluded virtually all of the major rock units of the shield, and the diverse subjects included the care-earth contenti al the Mesozoic dikes, soil development arer copper deposits, argon daring of Venezuelan dikes, and stromatolites in the Culiencranquent Group. New geochronological data were presented for many parts of the craton. There is controversy converning the proportion of the cratim that existed prior to the Early Protegozoic: At our extreme, most of the craton is considered to be Arrheau, while others think that only the Imataca Province of Venezuela has been proven to be Archean. Similarly, though much of the crust of the western part of the cranic has yielded hate Proteroroic ages, there is controversy about whether these ages represent new crustal ad-ditions or reworking of older crust. There were several presentations by government and company geologists who have been soccessful in recent infinitely exploration in the Amazonian region. Breno dos Santos reported on the work of IGCEGEO in the Seria dus Carajas region, which has promising de-posits of iron, emper, gold, manganese, and

several other metals. Other papers described the Seis Lagus carbonathe exploration, the Pitinga tin deposits, and the Trombetas bouxite. Field trips to Carjas, Rondonia, Trombeias, and Boa Vista concluded the symposium.

A U.S. Working Group for this IGCP pro-ject was organized in late 1985 and was furmally approved by the U.S. National Committee for the IGCP at its December 1983 meeting. About a dozen geologists who have previously done research in either the Autazonian region or the correlatable rocks in West Africa have indirated their interest in the project and in the U.S. Working Group.
Many of the participants are involved in geochromological work, and they will bring to the
project a valuable contribution of isotopic laburatory work. Other members of the Working Group are active in regiunal stratigraphic and metaniorphic studies and paleumagnetic research. Recently formalized agreements between the Brazilian CNPQ and the United States National Science Foundation specificalencourage collaborative research hetween U.S. and Brazilian geologists. The National Science Fundation continues to support research by U.S. geologists in several other countries on the craton, and collaboration between U.S. geologists and the governments and companies in these countries also con-

tributes to the project's research goals.

Allan Gibbs of Cornell University is coordinating the U.S. Working Group, and any geoscientists interested in research un the Prerambrian geology of the region are wel-come. Correspondence should be addressed to Allan Gibbs, Department of Geological Sciences, Carnell University, Ithaca, N. V. 14853 [telephone 607-25ii-5282].

Geophysicists

William M. Kapla, chairman of the depart ment ul earth and space sciences at the Unireraity of California, Los Angeles, has been chusen tu head the National Oceanic and Atmospheric Administration's National Geodetic Survey Division (NGSD), effective in September. His duties will include the readjust ment of the horizontal network (NAD83), the readjustment of the vertical network (NAVD88), the newly started POLARIS VLBI carth rotation and polar motion service, and the introduction of the Global Positioning System to control surveying and its

application to geotlynamics. Kanla has been a professor of geophysics at UCLA since 1963. Louis J. Lanzerotti, at Bell Laboratories in Murray Hill, N. J., has been appointed chairman of the National Aeronautics and Space Administration's (NASA) Space and Earth Science Advisory Committee. He succeeds Laurence A. Soderblom of the U.S. Geologica Survey, Flagstaff, Ariz. The next meeting of the cummittee is scheduled for the end of

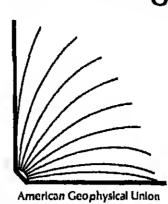
Jesse W. Mooro has been appointed associate administrator for space flight at NASA. He has been serving as the acting associate adminstrator for space flight since April 15, 1984. He was appointed deputy associate administrator for space flight in February

Eugene M. Shoemaker of the U.S. Geolugical Survey and David Stevenson of the California Institute of Technology will receive the Kuiper and Urey prizes, respectively, awarded by the Division for Planetary Sciences of die American Astronomical Society. The Kuiper Prize is given annually in recognition of a scientist whose achievements have advanced significantly the understanding of planetary science. The Urey Prize, also awarded annually, recognizes and encourage uutstanding achievement in planetary science by a young scientist. The prizes will be awarded at the AAS annual meeting in Octo-

The following AGU members were elected as Fellows of the American Association for the Atlrancement of Science on May 28: Charles C. Bales, Norman H. Brooks, Kennelh Davies, Robert E. Dickinson, J. Ernest Flack, Dave Fults, J. Frederick Grassle, Donald M. Heuderson, Andrew P. ingersell, Stig Lundq-vial, Michael B. McEltoy, Leslie H. Meredish, James N. Pills, James V. Taranik, John Ver-hoogen, and M. Gordon Wolman.



Yours for the asking



PUBLICATIONS CATALOG

You can have your own guide to AGU's current selection of books and periodicals. This catalog contains brief descriptions, prices, and order forms.

For your free copy, write or call:

American Geophysical Union 2000 Florida Ave., N.W. Washington, DC 20009

(800) 424-2488

Does your library subscribe to Tectonics?

Classified

RATES PER LINE

Positions Available, Services, Supplies, Courses, and Announcements: hist inscribin \$5 tht, int-

Position Ronted: first neer toon \$2 to, addison al insertion \$1.50 Student Opportunities has inversion lice, addi-

There are no discounts at countriesons or lassified ads. Any type style that is not publish er's chone is charged at general adventising rates. Los is published weekly our Tursday. Adv prior to the date of publication.

Replies beads with his minders should be addressed to Box ____. American Geophysical Umon, 2000 Florida Avenue, N.W., Washing-

For more information, call 202-462-6903 or told free 800-424-2488.

POSITIONS AVAILABLE

Airborne Research Amociates/Atmospheric Scientiat. Airborne Research Associates is seeking an that. Airborne Research Associates is seeking an experienced annospheric cientist skilled in efectronics, FONTRAN programming and statistic for meteorlogical/geophysical basic research. Primary responsibility is rouning a patellite image analysis investigation of large scale rhord variability using a specially developed interactive FDP 1023 havel assument. The secondary responsibility incohes participation in articals infectionlogical field programs. Research areas including and matural programs. Research clearing and organized programs in budges and maturolaptical and organized processes including intermitable and organized convection. Applicant should be a versalle self-start-er. The company is small with asymiated advantages and disadvantages. Send resume, salary, three refrrences to Dr. R. Markson, ARA, 46 Kendal Com-

Research Associate. The Department of Geosciences at the University of Arizona authipates for one-year positions for research associates diving 1081-85 with experience in stable isotope mass spectrometry and vaconin line experience. Both positions require a fundamental understanding of stable isotope geochemism? One position entails carrying out research in stable alborate isotope variation. The other entails studying tariations of stable carrbons isotopes in tree thogs. Salary but both positions will be \$16,000. Ph.D. required. Three two positions are dependent upon correct grant continuation with possibility of extension for one additional year. The applicants are orged to apply Applicants should send what with the statue and delephone number of three references to Dr. George Davis, Department Head, Department of George Lavis, Department Head, Department of George Ravis, Department of Arizona, Tucson, AZ 83721.

The University of Arizona is an Equal Opportunity/Allurmative Action Employer. Research Associate. The Department of Geosci-

Oceanographic Programmer and Techolelan)
Skidaway Inatitute of Oceanography. Skidaway
Institute of Oceanography Lies an opening for a scientific programmer and technician. Preference will
be given to applicants with an M.S. degree in an
ocean or other geophysical science, but others with
at least a B.S. will be considered. The applicant
most degronstrate profeciency in FORTRAN and
other suricis of communer science, unricularly the other aspects of computer science, particularly the

Interfacing at occaning raphic equipment in software development and data management. Salary is nego-tiable and will be commensurate with experience and training. We anticipate filling this position on or before I November 1984.

or bettere I Niverther 1984.
Interested persons should send a resume including the tantev and addresses of three references to:
Dr. J.O. Blanton
Skidaway Institute of Occaringraphy
P.O. Box 13647
Savantah, Georgia 31416
912-356-2437.

Project Associate/Specialists Electron Micro-Probe Lab, University of Wisconsin-Madison. Strong analytical background in quantitative EMP analysis and familiarity with computers is required. The Lab has a 9-spectrometer ARL SEMQ and a JEOLCO 50-A SEM. Duties will include instrument maintenance, instruction of students, development of procedures and analysis. Research will be encouraged. A MS nr PhD is required in Easth Science, Chemistry, Physics or Engineering. Minimum salary will be \$18,000/12 months with an MS. Send letter of application, transcripts, resume, and names and addresses of three references by September 15 to Dr. Juhn W. Valley, Department of Geology & Geophysics, Weeks Hall, University of Wisconsin, Madison, WI 53706.

An equal opportunity employer.

Stanford University/Plasma Physics, EAI Waves, Space Physics. We are seeking a senior person who has demonstrated srientific, managerial, and leadership qualifications in one or more of the following disciplines: Spare Plasma Physics, electromagnetic waves, and solar-terrestrial physics. We expect the sucressful randidate to have established an ounstanding repotation idocumentalse through professional writings or other evidence of personal technical creativity, letters of reference from recognized revearch leaders in the disciplines mentioned above, and/or awards and other recognition from appropriate professional societies.

It is expected that this individual will develue a

It is expected that this individual will develop a research program in one of the disciplines given above working in coordination with tragoing programs within the STAR Jaboratory and, possibly, with other activities within the Stanford Center for Space Science and Astrophysics. It is expected that this individual will have a strong background in experimental techniques, either in the laboratory or in the field, including the environment of space; experimental activities in either laboratory or space plasma julysics would be regarded as good qualifications. However, clave association with theoretical developments in plasma physics and/or electrismagnetic theory will cleanly be desired. It is also expected that the intilvidual will have a demonstrated capalitity for recurring federal or other research grant support, or be deemed by the selection committee of being rapable of securing such funds.

port, or be deemed by the selection committee of being rapable of securing such funds.

It is anial pated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of Electrical Engineering Department, including, when time permits, teaching graduate and undergraduate classes, serving on various committees in the department, school of Engineering, and the University. It is expected that the person chosen will participate actively in the training in graduate students.

The Libarman of the selection committee for this position is Professor Rubert A. Helliwell, Professur of Electrical Engineering, Space, Telecommunications, and Radioscience Laboratory, Stanford University, Stanford, CA 94395, Other members of the selection committee include Professor P.M. Banks, Professor R.N. Bracewell, Professor L.R.O. Storey, and Professor L. Tyler,

Geologiats-Geophysiclats/Institute for Geophysics, The University of Texas at Austin. The Institute for Geophysics at the University of Texas at Austin has upenings for research staff, particularly in the areas of theoretical scisnology and sea-going marrine geology/geophysics. The Institute is located in Austin and operates chosely with the Department of Geological Sciences of the University. It is a vigorous and growing group with interests in both land and marine geology/geophysics. Research lacilities include a 169-toot ship equipped with multi hannel and high resolution sciumic reflection and OINs seismic refraction rapphilities. A VAX 11/780 computer with INSCO soft ware is available for data processing.

with filsCO software is available for data processing.

Applicants should hold a Ph.ft. In geology, geophysics or other appropriate field and have demonstrated creativity in research. Senior and midstared researchers as well as recent Ph.U.'s are encouraged to apply. Applications should be tereived by September 15, 1984. The salary is dependent down qualifications. Please forward applications, curriculom viace, names of at least three references, and other supporting materials to: Or. A.F. Maxwell, Hirector, Institute for Geophysics, The University of Texas at Austin, P.O. Box 7456, Austin, T.X 78712.

The University of Texas is an equal apparamity/affirmative action employer.

Geochemiat. The University of Cdifurnia, fava, Ucpatrinent of Geology, has an opening for a one year temporary faculity position for Fall 1984. Specific fields are open; however specialization in isompe and economic good hemistry are desirable. The Department has strong programs in patentiology, patenceanography, petrology, geophysics, and croat and mante evolutions. A Ph.D. is required. Responsibilities include graduate and undergraduate teaching and research in geochemistry.

Applicants should admit vira, statement of research and teaching interests, and the names of three references as soon as possible, as the position is for the Fall, 1984 quarter.

We anticipate that this position will be opened on a permanent, tennic track basic during the next academic year. A successful cambidate for this temporary position can apply for the tennic track position, inquiries and applications should be sent to Chair, Search Cammittee, Department of Geology, University of California usual to University of California is no could opportunity.

The University of California is an equal opporta-

RESEARCH PHYSICIST, ASTROPHYSICIST, OR \$36,327 TO \$55,807 PER ANNU (Salary de)

The Spectroscopy Section of the Solar Physics Branch. Space Science Division is engaged in ultraviolet solar research by means of ground-based observations, sounding tackets, and manned and unmanned

We invite applications for the position of Project Scienhst for a major satelline experiment which will fly on the Upper Almospheric Research Satellite. The selectee will conduct investigations to develop the technical tools necessary to study the variability of the Sun in the ultraviolet spectrum. He/She will be a co-investigator of the NRL-UARS experiment, in this capacity the selectee will conduct his/her own research in the area of solar variability and/or upper earth atmospheric physics

Qualifications required: A bachelors or higher degree in physics and at least three years of professional experience which involved performing basic and/or applied research in the fields of optics, spectroscopy, solar physics, or geophysics.

interested applicants should submit a Personal Qualifications Statement (SF-171) or detailed resume by 28 September 1984 to:

(Salary dependent upon qualifications)

SPECTROSCOPY SECTION SOLAR PHYSICS BRANCH SPACE SCIENCE

DIVISION NRL NAVAL RESEARCH

LABORATORY Ann: 41-58-13.1 (EOS) 4555 Overlook . Avenue, S.W.

Washington, D.C. 20375 An Equal Opportunity Employer U.S. Chizenship Required

Niller, Scripps Institution of Oceanography, A-030, La Jolla, CA 92093 by The University of California, San Diego is an Equal Opportunity Affirmative Action Em-

Scripps Institution of Oceanography

Postdoctoral in

Physical Oceanography

Scripps Institution of Oceanography invires applications for a Postdoctoral

position in Physical Oceanography to participate in rheoretical and observa-

tional studies of the general circulation of the North Pacific Ocean. Ph.D.

ground in Fluid Dynamics, is required. Salary is commensurate with experi-

ence, wirh a minimum of \$22,600 per annum. Position start date from Oc-

Please send resume and rhree letters of reference to Professor Pearn P.

in physical or marhematical sciences, with a strong graduate level back-

WEATHER DATA ANALYSIS INTERACTIVE SYSTEMS DESIGN PROFESSIONAL OPPORTUNITIES

The University Corporation for Atmospheric Research, headquattened in Boulder, Colorado, invites applications and nominations for the first two positions available with our UNIDATA project PROJECT MANAGER and TECHNICAL COORDINATOR, UNIDATA is a collaborative project whose next plass will involve the development of system specifications for hardware, high-active software, and a wide-area wild throughous the academic communications network system enabling users in the academic community to conduct local interactive analysis of tunestated duct local Interactive analysis of runven-floral and advanced weather data provid-ing access to maintraine computers PROJECT MANAGERI Provides over

all project management and ensures that the UNIDATA system is responsive to the needs of the accelerate community. Re-quires: MAMS in insteading planed field or equivalent combination of educadon and experience still in project man agement and in hudget planning and management stell in technical writing skill management, stell in technical writing stell in developing and maintaining effective diplomatic working infaituriships with diverse communities, expert knowledge in one with working learninkal areas. 1) research leaching use of meteorological rists. 21 data communications. 3) software systems & meteorological applications. 4) graphics display workstatum, systems. Salary, 553-501, 557-600 or depending upon qualitications.

qualifications.

TECHNICAL COORDINATOR: Integrates the technical and engineering aspects of system design Requires. MA MS in meteorology with computer applications exp., MA MS degree in computer science with meteorology applications exp. or equivalent conditionation of edication expertance, expert knowledge and skill in strikume systems & data communications skill in technical writing and project task plauning; working knowledge of graphics display working knowledge of research teaching use of meteorological data. Sakay \$30,381.

THESE ARE ONE-YEAR TERM INSTITUTES WITH THE POSSIBILITY OF EXTENSION.

UCAR to a university rousoritum com-posed of 5t IJ.S and Canadian Institu-fons dedicated to the advancement of the atmospheric and related sciences. UCAR's principle activity is the operation of the Nahonal Center for Atmospheric Research under the sponsorship of the National Sci-ence Foundation.

APPLICATION PROCEDURE: Please submis resumé in confidence to Nancy Lippincott, Employment Ad-ministrator, N.C.A.R., P.O. Box 3000, Boulder, Colorado 80307.

in Equal Opportunity Affilms the Action Employer

Selamologist/Department of Geology/Holversity of Illinois at Urbana-Champalgn. Applications are solicited for a tenure track position at the Assistant Professor level in the general area of seismic imagery. The position is expected to be filled by Fall, 1985. Salary is commensurate with experience; an earned Ph.D. is required. A creative individual is sought who will develop a research program that can complement our existing programs in goodynamics, earthquake seismology, geolectonics, and rock/mineral physics. Specialists from subields including reflection/refraction seismology, marine or continental seismic profiting, and seismic tonography are encouraged to apply. An excellent research environment and outstanding facilities are available both in the Department of Geology and the University. Opportunity exists to incite the litinois State Geological Survey on campus. The successful candidate is expected to paticipate in all aspects of tenehing and advising at the graduate and undergraduate levels. For equal consideration, interested undividuals should send curriculum vitae, list of publications, statements of retearch interests and names of three or more references by December 15, 1984 to: retearch Interests and names of three or more ref-creaces by December 15, 1984 to: Professor Albert T. Haul

Partment of Geology
Inversity of Illinois at Urbana-Champaign
I W. Green Street na, Illinois GISGI Sephone: 217-333-7732 or 333-3542 University of Illinois is an equal opport

MARINE **CHEMIST**

The Chemistry Department of the Woods Hole Oceanographic Institution plans to make a tenure track appointment a Assistant Scientist and invites applica ions from reseachers with interest in the field of Marine Chemistry. Applicants should have a Ph.D., and preferably, post doctoral experience with a demonstrates Interest in natural systems and strong basic physical, organic or analytical chemistry background to study chemical processes in marine systems. Experience with techniques in reaction kinetics and mass spectrometry would be particularly valuable. Interested candidates should send resume, transcript, reprints and names of potential referees, to:

Box 54 P



WOODS HOLE **OCEANOGRAPHIC** INSTITUTION

Woods Hole, MA 02543

Hydrogeologia/Texas A&M University. The Department of Geology and Center for Engineering Geosciences have a tenure track opening, preferably assistant professor lettel, for which the first search will be for a creative individual working in applied geological hydrology.

The successful applicant will be expected to develop teaching and research recognition at a national level. The position is available beginning September 1, 1984 and will be held open until filled. Applirants should submit a vita including names of references to M.C. Unibert, Department of Geology, Texas A&M University, College Station, TX 77843.

Texas A&M University it an offirmative action/equal opportunity employer.

University of Texas at Austin. The Department of Geological Sciences seeks to fill tenure track positions effective fall 1985 in one or more of the following disciplines: 1) micropaleontology-Teudary biostratigraphy, 2) situeture-tectonics, 3) hydrogeology, and 4) mineralogy-kinetics. Each person is expected to teach both undergraduate and graduate courses and to conduct a vigorous research program, including the supervision of graduate students, in the area of his or her speciality. The postuons require the Ph.D. degree, Applicants should submit a detailed resume, names and addresses of five references, a statement of teaching and research interests, and a copy of their dissertation abstract by December 1, 1984 to: Dr. William L. Fisher, Oepartment of Ceological Sciences, the Universi-Texas at Austin, Austin, Texas 78713-7909. The University is an equal opportunity/affirma-

dive action employer.

Univarilty of Texas at Austin. The Department of Geological Sciences invites applications for a person to teach depositional systems and petroleum geology at the indergraduate and graduate levels and to conduct a vigorous research program, including the supervision of graduate students, in the area of the person's interest. The person must be willing to teach the above subjects to non-nojors on accessive. The position requires the Ph.D. and is upen to both tenure-seeking junior persons and senior-level persons. Availability by January 1985 is desirable. Applicants should submit a detailed resume, manes and addresses of five references, and a statement of teaching and research interests by November 1, 1984 to Dr. Easle F. McBride, Department of Geological Sciences, University of Texas, Austin, Texas 78712. New Ph.D.-holders should also submit a copy of their dissertation abstract.

The University is an equal opportunity/affirmative action employer.

POSITIONS WANTED

Teaching aud/or Research — Geology, Paleontology, Geophysics, Mining and Petroleum Engineering. Extensive practical and teaching experience in the US and abroad. Specialist in resource eapleration and development—multilingual with fluent ration and development—multilingual with flue Persian and Turkish! Salary and rank negotiab Reply to Box 026, American Geophyl 2000 Florida Avenue, N.W., Washing

IN PETROLEUM GEOLOGY Salary is in scale 32 Nkr. 207 735 p.a. gross, of which Nkr. 3

The University of Bergen invites applications for a vacant

PROFESSORSHIP (CHAIR)

649 p.a. are paid in pension contributions. The professor will be appointed on the understanding that any changes in scientific duties, pension or retiring age made by law or by the King with the agreement of Parliament are to be accepted without compensation.

Applicants should submit 5 copies of scientific work—published or unpublished—which they wish to be considered for the appointment as well as 6 copies of a list of all scientific contributions with information on where they are published. Scientific contributions are to be submitted, in numbered order and in 5 groups, to the science faculty of the University of Bergen within one month of the closing date for applications. Scientific manuscripts in preparation may be submitted within 3 months of the closing date for applications provided notice uf intent is given on submitting the other publications. Applicants are otherwise referred to the current rules for the procedure to be followed in the appointment of professorships and readerships.

A résumé of the vacant professorship can be obtained on request from: Sekretariatet for Det materatisk-naturvitenskapelige fakultet, Postboks 25, 5014 Universitetet i Bergen, Nortvay.

Applications from women are especially encouraged, in accordance with the policy of the university.

Applications, which must include a complete curriculum vitae, should be addressed to the King and be sent together with relevant certificates and one copy of a list of publications to: Det matematisk-naturvitenskapelige fakultet, Postboks 25, 5014 Universitetet i Bergen, Norway before 1st November 1984.

Geohydrologists/Hydrogeologists

CH2M Hill, an employee-owned, multi-discipline Consulting Engineering firm with regionel and project offices throughout North Americe and oversees, has positions for Geohydrologists/Hydrogeologists in the following offices: Redding, CA; Denver, CO; Gelnasvilla, FL; Portland, OR; Seettle, WA end Milweukae, WI.

Positions require a BS in Gaology, Civil or Agricultural Engineering and a MS in Groundweiar Hydrology or Hydrogeology with a besic understending of geology end a thorough knowledge of aquillar mechanics, geochamistry, end computer modeling. Must here interest in project menagement, business and computer modeling. ness development, end work in a teem concept situation. Prater e minimum of S yeers consulting angineering experience and total professional experience of 7 to 12 years. Qualifications should include working experience in:

- Groundwater resource evaluation and supply dasign. Groundwater quantity and quality monitoring program design and
- Groundwater quantity and quality modeling.

Salary commensurate with experience, excellent (rings benellis. An Equal Opportunity Employer. Qualified epplicents eend reeums indicating gao-graphic preferance end setary requirements. In confidence, to Menager of Recruiting GEOHYG3, CH2M HILL, P.O. Box 428, Corvallis, OR 97339-



Engineers **Planners** Economists Scientists

AGU's toll-free number is in operation Monday through Friday, 8:30 A.M. to 5:00 P.M.

Use this number to:

Tall Free

800-424-2488

· Changa your mailing address Order books and journals

Request membership applications

Register for meatings Request a Publications Catalog

You also may call and request Information on:

· Insurance

· Scholarship programs

Chapman conferences and AGU meetings

· Price lists for Journals



Housing and Registration

The 1984 Fall Meeting of the American Geophysical Union and the Winter Meeting of the American Society of Limindagy and Oceanography (ASLO) will be held in San Francisco, December 3-7, at the Giele Andi-

San Francisco has been host to AGU's anmual Fall Meeting for many years. If you have attended previous Fall Meetings, you know what a pleasing city San Francisco can he—tine restaurants, temperate December dimate, and the charms of Chinatown, China-delli Square, Fisherman's Wharf, Noh Hill, and North Beach. San Francisco is an elegant city, offering a vich blend of stylish hospitality and home town anniability. By any measure, San Francisco is an ideal backdrug for this year's scientilin sessions.

Registration

Everyone who attends the meeting must register. Preregistration received by Nascanber 9 saves you time and money. The fee will he refunded to you if ABU receives written notice of rancellation by November 30, Registration rates are as follows:

Preregis: Alter No vember 9 Member (AGU/ASLO) \$70 Sindent Member (AliC) (AGU/ASLO) Age 65 or over and retired from full-time

Nonnember Student Nonmember

Registration for I day is available at one hall the above rates, either in advance or at the meeting. Members of the American Congress on Surveying and Mapping, the American Meteorological Society, the American Society of Plunogrammerry, the Canadian Geo physical Union, the European Geophysical Bujon, and the Union Geoffsica Mexicana may register at the AGU/ASLO member

If you are not a member of AGU and you register at the full nonmember incetting rate, the difference between member (or smilent member) registration and nonmember regis-tration will be applied to 1985 AGU dues if a completed membership application is re-ceived at AGU by February 28, 1985.

To preregister, lill out the registration form, and return it with your payment to AGU hy Navember 9. Preregistrants should pick up their registration material at the registration desk located at the Cierc Auditornia in the Main Arena. Your receipt will be included with your preregistration material. Registration hours are 7:45 A.M. to 4:30 P.M., Monday through Friday. On Sunday, December 2, registration will be held at the Cathedral Hill Hotel. You may register from 4:00 P.M. to 8:00 P.M.

Hotel Accommodations

Blocks of sleeping tooms are being held at the following hotels:

• Carbeilral Hill Hotel (\$51 single/\$55 don-

Free parking to registered guests Limited shuttle service to and from the

Airport shuttle service available tadlee shop opens 6:30 A.M. Holiday Inn Golden Gateway (\$49 single/

Sis thuble) Free parking to registered guests Limited shuttle service to and from the

Clvic Anditorium Airpurt shuttle service available Coffee shop upens 0:30 A.M.
• The Grosvenor Inn (\$49 single(\$55 thus

Limited shrute service to and from the Civic Auditorium

Airport shuttle service available Coffee shop opens 7:00 A.M. The Holiday Iun Givic Center (\$49 sinTwo blocks away from the Civic Audito-

Free parking to registered guests Collec slipp apens 6:30 A.M. The San Franciscan Hotel 1\$50 single/\$50

One block away from the Cicic Ambitori-Airport shintle service available

Parking \$3 a day to registered guests Coffee shop opens 6:30 A.M. • Carriage Inn Hutel (\$52 single/\$54 dou-

Victorian style inn Free parking to registered guests Vialking distance to the Civic Auditorium Shunle service available to airport Free commental breakfast and newspa

• Americania Hotel (\$49 single/\$51 double) Free parking to registered guests Walking distance to the Civic Auditorium Walking distance to the Civic Authorities
Shanks service available to airport
Free coffee served in sleeping rooms
• Flaminga Mator Inn (\$43 single/\$43 dou-

Free parking to registered guests Walking distance to the Civic Auditorium Shuttle service available to airport • Harel Britton (\$35 single/\$38 double)

Inexpensive parking available to regised guests Walking distance to the Civic Auditorium Coffee shap opens 7:00 A.M. Shared barbs

The Cathedral Hill, Hediday Inn Gelden Gateway, and the Grosvenor lictels are ap-proximately a mile away from the Givic Audi-torium. Limited shumb bus service will be provided from these hotels to the Civir Audi-

arium for those who do not want to walk. Real the housing application, and mail the completed application form to the housing bureau early to ensure reservations at your preferred hotel. Reservating forms must be sent directly to the Housing Coordinator, AtiU Fall Meeting, San Francisco Housing Bureau, P.O. Box 5612, San Francisco, CA 94101. Do not send housing resercation

NAME ON BADGE

AFFILIATION (for badge)

TELEPHONE #

Days you plan to attend

HOTEL

MAILING ADDRESS _____

Please check the appropriate box(es)

Please check appropriate box.

register at AGU member rates

☐ Member cooperating society

□ Mon □ Tues □ Wed □ Thur □ Fri

☐ Member AGU ☐ Member ASLO ☐ Nonme

☐ AMS-American Meteorological Society

☐ EGU-European Geophysical Union

☐ CGU-Canadian Geophysical Union

UGM-Union Geofisica Mexicana

Preregistrants

☐ ASP-American Suciety of Photogrammetry ☐ ACSM-American Congress on Surveying and Mapping

Nembers of ASLO and the cooperating societies may

If you register at the full-meeting nonmember rate,

plied to AGU dues if a completed membership applica-

Your receipt will be in your preregistration packet:

The registration fee will be refunded if written notice

of cancellation is received in the AGU office by No-

vember 30. The program and meeting abstracts will

appear in the November 6 issue of Eos.

the difference between member (or student member)

registration and nunmember registration will be ap-

tion is received at AGU by February 28, 1985.

RETURN THIS FORM WITH

PAYMENT TO:

Meeting Registration

American Geophysical Union

2010 Florida Avenue, N.W.

Washington, D.C. 20009

Or Call: Toll free 800-124-2488

Meetings 202-462-6903

PLEASE PRINT CLEARLY

Reservations must be received by October 3) to be confirmed. Do not write or call AGU for room reservations.

Scientific Sessions

The Call for Papers, including specifications for abstracts, was published in the July 3 and August 14 issues of Ew. The program summary will be published in the October 16 issue of Ew. The preliminary program with the abstracts will be published in the November 5 issue of Ew. The final meeting program with proceeding times will be distributed. gram, with presentation times, will be distrib-used at the meeting. All scientific sessions will be held at the Civic Auditorium.

Exhibits

Exhibits of instrumentation equipment book publishers, program of government agencies, and other exhibits will be located at the Civic Anditorium in the Main Arena. The exhibits will be open Tuesday, Derember 4, through Thursday, December 6, 9:00 A.M. to

The following exhibitors are confirmed to

Academic Press American Congress on Surveying and Mapping
American Society of Limnology and Ocean-

grapmy Elsevier Science Publishing Company, Inc. Jer Propulsion Laboratory/TOPEX Project Cinemetric, Inc. Kluwer Academic Publishers (D. Reidel) National Science Foundation

Nature's Own NOAA/National Ocean Service Pacific Delight
Qualimetrics, Inc./Weathertronics Schousiedi Instrument Company Sprengnether Instruments Springer-Verlag, New York Office

Teledyne Georech

Term Technology Corporation

Social Functions

All meeting participants are invited to at-

tend these events: Icebreaker party Monday, 6:00-7:30 P.M.

Holiday Inn Golden Gateway • Wine Reception

Thursday, 0:00-7:30 P.M. Catherina Hill Hotel Complimentary refreshments will be served daily at the Civic Andhorings

Business Meetings and Section Luncheons

The AGU Conneil will meet Tuesday, De-cember 4, at 5:30 P.M. Members are welcome

ASLO will hold a no-host smoker [cash bar), Thesday, December 4, at 5:30 P.M. The section luncheous will be held at the San Franciscan (SF) and Holiday Inn-Civic Center HHCC) hotels. Please indicate on the registration form which lunchem you plan to attend and include payment.

AGU Council Meeting Tuesday, December 4, 5:30 P.M. Cathedral Hill Heacl

ASLO No-Host Smoker Tuesday, December 4, 5:30 P.M. Carliedral Hill Heael.

Tuesday, December 4, Noon netism and Paleomagnetism (HICCI, \$11.50

Planetology/Volcanology, Geochemistry and Petrology ISFI, \$11.50 Seismology (SF), \$7.50

Wednesday, December 5, Noon

Geodesy (SF), \$11.50 Ocean Sciences/ASLO, (SF), \$11,50 Solar Planetary Relationships (HICC), Galeway Thursday, December 6, Noon Annospheric Sciences (SF), \$11.50

Hydrology (111CC), \$11.50 Tectographysics (SF), \$11.50, Speaker: Dr. Barry Raleigh, Director, L-DGO

AGU 1984 Fall Meeting DECEMBER 3-7 San Francisco, California

REGISTRATION FORM

ASLO WINTER MEETING

Deadline for Receipt of Preregistration November 9, 1984

trates applicable only if received by November 9 with payment

	More ilan me ilay	One
MEMBER	□ \$711	CR\$
STUDENT MEMBER	□ \$:311	515
*RETIRED SENIOR MEMBER	\$313	S15
NONMEMBER	SU5	\$47.50
STUDENT NONMEMBER	S-10	\$50
*Age 65 or over and retired from full-time	e emidoyme	nı

SECTION LUNCHEONS

Circle section and indicate number of tickers, All

. Geomagnerism and Palenmagnetism, Tuesday, \$11.50

Planetology/Volcanology, Geochemistry and Petrology, Tuesday, \$11.50

____ Seismology, Tuesday, \$7.50 ____ Geodesy, Wednesday, \$11.50

____ Ocean Sciences/ASLO, Wednesday, \$11.50

_ Solar-Planetary Relationships, Wednesday. \$11.50 ____ Atmospheric Sciences, Thursday, \$11.50

____ Hydrology, Thursday, \$11.50 ____ Tectonophysics, Thursday, \$11.50

Total Enclosed \$ ___ (All orders must be accompanied by payment or credit card information. Make check payable to AGU.)

☐ American Express Charge to: Visa ☐ Master Card

Card Number

Master Card Interbank No. Expiration Date __

Code Office Usa Check No

FALL MEETING SAN FRANCISCO DEC. 3-7

HOTEL ACCOMMODATIONS PARTICIPATING HOTELS

Carriage Inn

1800) 227-4368

Americania

1\$52 Single/\$54 Double)

)\$49 Single/\$54 Double)

140 Seventh Street

121 Seventh Street

Flamingo Molor Inn

114 Seventh Street

(\$43 Single/\$43 Double)

(\$35 Single/\$38 Donble)

112 Seventh Street

(800) 227-4368

(800) 227-4368

Holel Brl)lon

ASLO WINTER MEETING

Calhedral Hill Holel (\$51 Single/\$55 Double) Van Ness al Geary (800) 227-4730

Hollday Inn Golden (\$49 Single/\$55 Double) 1500 Van Ness Avenue

Grosvenor Inn (\$49 Single/\$55 Double) Van Ness al Geary

(415) 673-7411 Hollday Inn Clvic

(\$49 Single/\$55 Double) 50 8th Sircel (415) 626-6103 San Franciscan Holel

(\$50 Single/\$56 Double) 1231 Market Street (415) 626-8000

All hotel reservations must be made on the housing form by October 31, 1984. No telephone request will be accepted. Confirmations will be mailed directly to registrants by the individual hotels. A first nights deposit may be required by the hotel to guarantee your room. Changes and ennecllations should be made directly to the hotel.

Mail your completed housing form directly to:

Housing Coordinator AGU Full Meeting San Francisco Housing Burenu P.O. Box 5612 San Francisco, CA 94101

American Geophysical Union S 1984 FALL MEETING ASLO WINTER MEETING HOUSING REGISTRATION FORM

READ CAREFULLY and RETURN FORM DIRECTLY TO THE SAN FRANCISCO HOUSING BUREAU AT THE FOLLOWING ADDRESS:

> Hnusing Coordinator AGU Full Meeting SF Housing Bureau P.O. Bux 5612 San Francisco, CA 94101

Please print or type all information, abbreviating as necessary. Confirmation will be sent by the hotel to the individual named in Part I. If more than one room is required, this form may be photocopied.

DEST(Firm					Ι_	Γ	Γ	Γ	Ι_		I	Ι	T				\Box
	lly or	Firm						Γ	Γ		Ι.		I		Ι				\Box
	ny or	Firm	 	_	_	<u> </u>				٠	L.,								ightharpoonup
Сіміра	n) or	Firm	I	٦	_						F	ĖſĸC							
Civnipa	ny or	Fim					Γ	1	T	Т	T	ГТ	Т	Т	_	Т		\neg	
						—			_	_	-	L!		_	Щ.	_			
\Box	ГΤ	T	T	٦	_		T	1	T	Г	T	ГТ	Т		_	7		_	
diess n	PΟ.	Dox	Num	hei	_	Ь-	_		Ь.	_	ı	L!	Щ.		Щ.	_			
		Т	1	_		Г	T	T	Т	1	Г		_	_	ı		Υ-	Τ-	_
						<u> </u>	-		-	1	Sia	Ic/Prov			(Zip	· Ú.S.	<u> </u>	
\Box	Т	Т	Т	Т	_		Т	T	$\overline{}$	1	Г	т	\neg		\neg	_			
							ــــــــــــــــــــــــــــــــــــــ	ــــــــــــــــــــــــــــــــــــــ	ــــــــــــــــــــــــــــــــــــــ	1	Tel	Cphone	Nun	her	Ц.		Ш		
								Par	t II										
	diess in	diew of P O			ldiese in P.O. Day Number			diew of P.O. Day Number	ldiew or P.O. Day Number		ldiew or P.O. They Number	Sta	State/Prov	State/Prov. Telephone Num	State/Prov. Telephone Number	State/Prov. Telephone Number	State/Prov. Zig	State/Prov. Zip-U.S	State/Prov. Zip-U.S.A. Telephone Number

INSTRUCTIONS: Select FOUR Hotels of your choice from the list of participating facilities, then enter the name on the lines below.

First	Choice

Fourth Choice

NOTE; Rooms are assigned on n "First Come, First Served" order, and if none of your choices are available, mother facility will be assigned based on a referral system. A cut-off date is in effect; your application may not be processed if received after 14 days prior to your arrival date. AGU housing registration deadline is October 31.

Part III

INSTRUCTIONS: 1. Select type of room desired with arrival und departure dates.

2. PRINT or TYPE names of ALL persons occupying room.

3. If more than two persons share a room, check twin and the hotel will assign two double beds.

CHECK ONE		
SINGLE (Room with one bod one person)] HOUBLE (Room with one bed two persons)] TWIN (Room with two beds two persons)	Arrival Oase	Guest Names (Lust name first) 2 3

IMPORTANT NOTE: Hotel MAY require a deposit or some other form of guaranteed arrival. If so, instructions will be on your confirmation form.



SPECIAL AIRFARES AGU 1984 FALL MEETING AND **ASLO WINTER MEETING**

Special discount airfares have been secured for this meeting. Available from most cities within the continental U.S., the special airfares are lower than coach fares and in many cases lower than super saver fares. Available from more than 40 cities, these lares have unrestricted minimum stay requirements and no advance purchase. These special coach lare discounts are valid from November 28-December 12, 1984.

Tickets can be reserved and purchased only through CONFERENCE AIR SERVICES (CAS), the official air traffic coordinator for this meeting. To reserve your flight to San Francisco using these discounted lares, call Conference Air Service toll Iree 800-336-0277 between 9:00 am and 5:30 pm EST, Monday through Friday (or in Virginia and Washington, DC area call 528-0114). CAS will instantly confirm your reservation on an available flight at the bas) alreare consisient with traveler requirements.

Below is a sample of the round-trip airfarea that are CURRENTLY AVAILABLE TO AGU attendees as of August 1984 with the special discount lares alongside. Since ALL FARES ARE SUBJECT TO CHANGE WITHOUT NOTICE BY SUBJECT BY SUBJECT TO CHANGE WITHOUT NOTICE BY SUBJECT BY SUBJE TICE, PLEASE CALL EARLY. Only sample cities have been listed below. PLEASE CALL CAS for the applicable discount lare from your home city.

San Francisco, California • December 3-7, 1984

Regular Coach AGU Convention Round Trip Airfares To San Francisco Discount BOSTON \$952.00 \$431.00 **CHICAGO** 796.00 407.00 DALLAS/FT. WORTH 700.00 351,00 **NEW YORK** 938.00 463.00 WASHINGTON, D.C. 912.00 408.00

NOTE: In the event of an increase or decrease in published airfares, the AGU special fare will remain loweril